Space Weather Technical Forecast

Issued on Thursday 21 November 2024 at 12:17 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight Chance of R1 throughout. Periods of Slight Chance of G1 to start and end forecast period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured at GOES16 has been Moderate, with the largest flare a M1.1 at 20/1941UTC, most likely from Ex-AR3897 on the southwestern limb. The X-ray trace was otherwise very subdued, with a few low-end C-class flares observed.

There are currently up to ten sunspot regions on the disc, two of which are unnumbered. The main regions on the disc at present include AR3901 in the southeast, which comprises several symmetric penumbral leading spots, some of which have proliferated and migrated west in the period, with small trailing spots and pores. This region has several filaments strung through its trailing portion, making it potentially one to watch should it flare appropriately (for CME risk, especially as it nears the solar meridian). Further west, two Zurich 'Dro' groups showed mixed fortunes: AR3898 showed emergence and spreading of new spots in the period in the southwest, while AR3896 in the northwest showed spreading and areal decline. The majority of the remaining groups were small unipolar regions.

The Sun is currently quite starkly polarised in HMIBC imagery, which numerous small filaments and prominences populating the disc. A small filament eruption was observed leaving the southeast disc on H-Alpha and some EUV imagery (e.g. AIA304) around 21/0100UTC. This feature has been modelled and determined to be a most likely miss below and behind the Earth, crossing 1AU into the UTC evening of Saturday 23 November. Other filament and prominence-based activity was otherwise clear of the Sun-Earth line, and no Earth-directed CMEs were in evidence over the past 24 hours in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds at L1 measured by ACE continued to show a slow regime. The solar wind speed was within Background levels throughout in the upper 300s of km/s, possibly with a slight rising tendency in the current UTC day. The solar wind density was also within Background levels in single figures ppcc, but again with a rising trend - there is a possibility this may be a sign of a CIR leading CH93/-, however this is conjectural. The IMF was variable, with Slightly Elevated highs of up to 10nT. The north-south component was initially mainly co-aligned with the Earth's field, but also developed a more erratic tendency as the period went on, ranging between +8 and -7nT. The phi angle was erratic, mainly away from the Sun (positive) before 20/2100UTC, and mainly negative thereafter.

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The net result of the above solar wind measures was provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 remained at Background levels.

High energy electron flux (greater than 2MeV) observed by GOES16 was mainly at Normal Background levels. The associated 24-hour fluence remained below the Active threshold with a falling then level tendency, and the 24-hour integrated flux observed at 21/0001UTC was 1.91e6.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a slightly falling Chance of M-class flares with the departure of two recent larger sunspot groups.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast.

A pair of coronal holes are due in the forecast period: firstly within the first 24 hours and again later in the UTC weekend. There is a Slight Chance of G1 for both, with an intervening lull, although Active intvervals are considered a more likely maximum.

Energetic Particles / Solar Radiation: There is a falling Slight Chance of S1/Minor Solar Radiation storms over the period, chiefly due to any potential significant flaring from Ex-AR3889 and Ex-AR3897, with negligible additional contribution from the Earth-facing groups.

High energy electron flux is likely to vary between Normal Background and Moderate levels throughout the period. The associated fluence is expected to remain below the Active (1e8 integrated flux) threshold.

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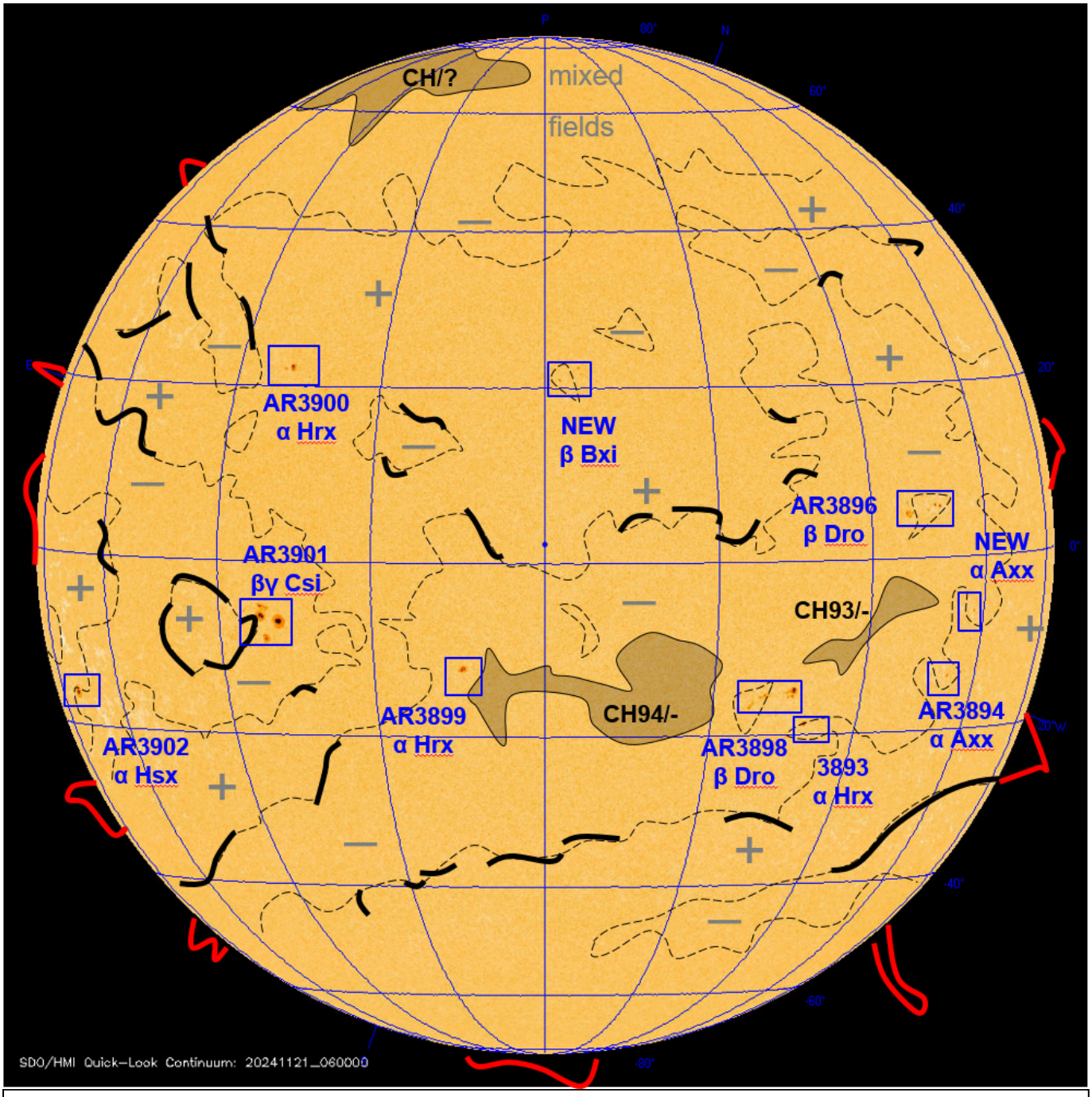
Figure 1: Solar synoptic map, valid 21/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are currently no Earth-directed CMEs in the forecast. The filament eruption from the southeast disc at 21/0100UTC has been modelled and initial assessments appear to show a close miss later in the UTC day of Saturday 23 November, to no effect at Earth. This will be reviewed should more information come to light.

Geomagnetic activity is therefore expected to be dominated by emerging fast winds, firstly from CH93- and subsequently CH94-. The former now appears quite tenuous in EUV imagery (e.g. AIA211) but was more visible before midweek UTC - when the solar wind that is due to affect Earth departed the Sun. A Slight Chance of G1 is maintained for this feature, probably peaking in the next 24 hours and the risk is therefore partitioned between the first two UTC days. A lull should then ensure before any subsequent fast wind arrives from CH94/-. This is expected to be the more noteworthy of the two features, with speeds of perhaps 550km/s, however it carries negative polarity which is generally less potent at this time of year and Earth is in any case now nearing the semi-annual minimally potent solstice.

All considered, there are two peak periods of a risk of G1: in the next 24 hours and then again later in the UTC weekend, however Active intervals are considered a more probable maximum.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	5	10	1	20
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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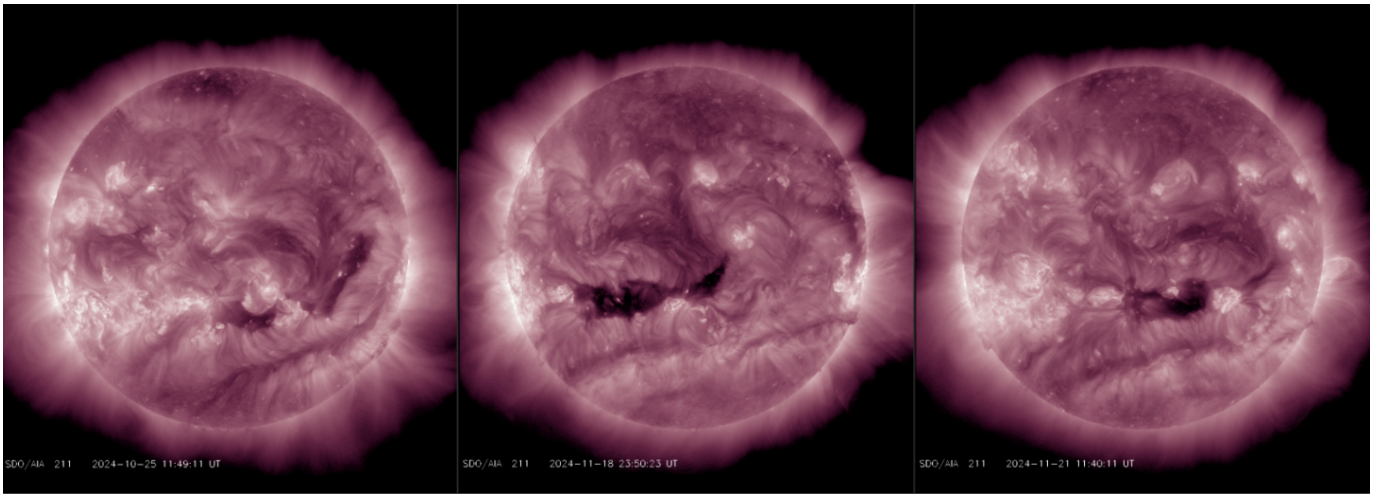
Figure 2: Series of views of coronal holes CH93/- and CH94/- and their predecessors. From left to right: last rotation on 25 October; current rotation on 18 November, nearer the time the solar wind that will affect Earth departed the disc and with fewer viewing angle constraints; current appearance (showing faint appearance of CH93/- in particular).



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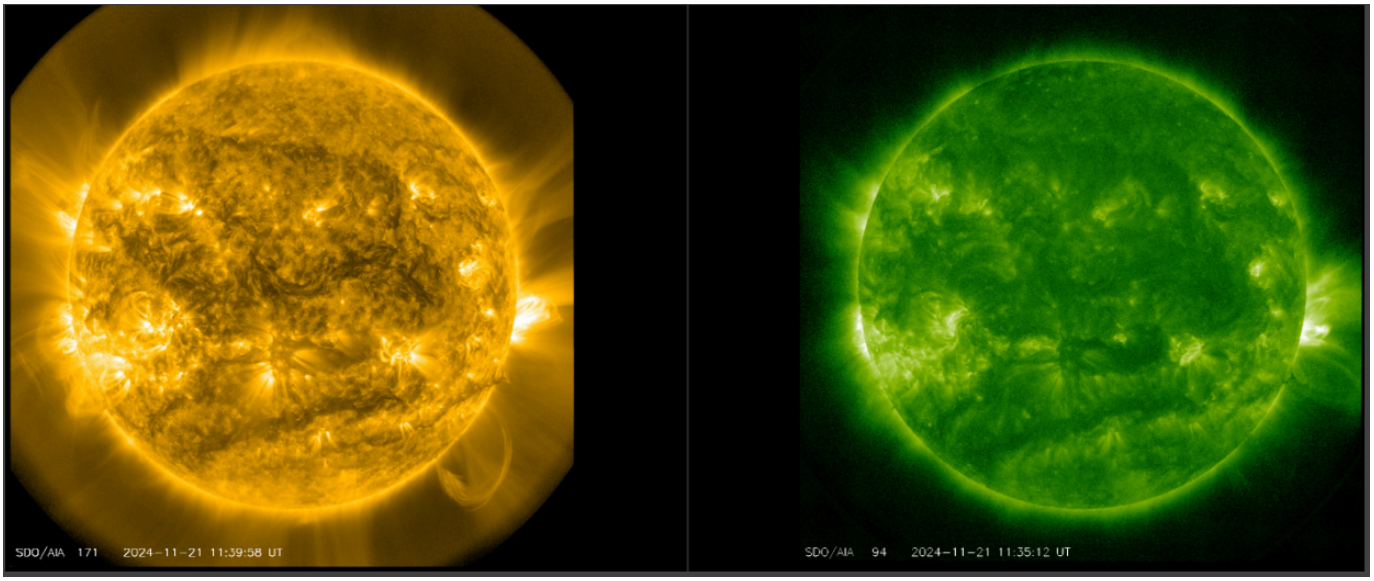
Radio Blackouts - X-Ray Flares

The current Earth-facing disc is offering little in the way of significant sunspot regions - while there are up to ten on the disc, the vast majority are magnetically unipolar or else small dipoles. The main exceptions to this in terms of complexity have been AR3901 as a Csi/Beta-Gamma in the southeast, and the Zurich Dro groups of AR3898 and AR3896 in the west, although none is currently proving generative of significant flares.

Regarding the balance of sunspot region populations, there remain a few further signalled to arrive over the eastern limb over the remainder of the UTC working week, with one perhaps now presenting as EUV flux looping over the eastern solar horizon. Any increase to risks as a result remains to be seen, however there are no further significant departures due. Ex-AR3889 and Ex-AR3897 should soon pass sufficiently onto the far side to no longer contribute to the daily risk, and the overall effect is for a decreasing Chance of M-class activity.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	50	40	40	40
Very Active	R3-R5 (X Class)	No	5	1	1	1

Figure 3: AIA171 and 094 imagery from 21/1135UTC showing flux looping on the offgoing southwestern limb and oncoming southeastern - both likely more substantial sources of EUV bright flux when compared with the remainder of the current disc.



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Solar Radiation Storms (High Energy Protons)

There is a slight chance of S1/Minor Solar Radiation storms over the period, chiefly due to any potential significant flaring from Ex-AR3889, now just around the western solar horizon, but also Ex-AR3897 which is following closely behind. The remainder of the Earth-facing disc is largely the preserve of unipolar or unremarkable bipolar groups, and does not add any appreciable risk to the daily probabilities of S1 in the near term.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

Electron flux levels at GEO have been sitting around Background levels, but at times reaching Moderate. Electron levels are likely to trend downwards, sitting comfortably at Background levels as the Van Allen belt compresses due to increase solar winds from the connections into CH93- and CH94-. From Day 3 (23 Nov), electrons may temporarily increase as the Van Allen belt expands back to the location of GEO.

The initial values unlikely to be of sufficient magnitude to trouble the Active 24-hour integrated threshold - no persistent feature on the disc has resulted in Active fluence. MOSWOC REFM output viewed as providing reasonable guidance at present.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	5	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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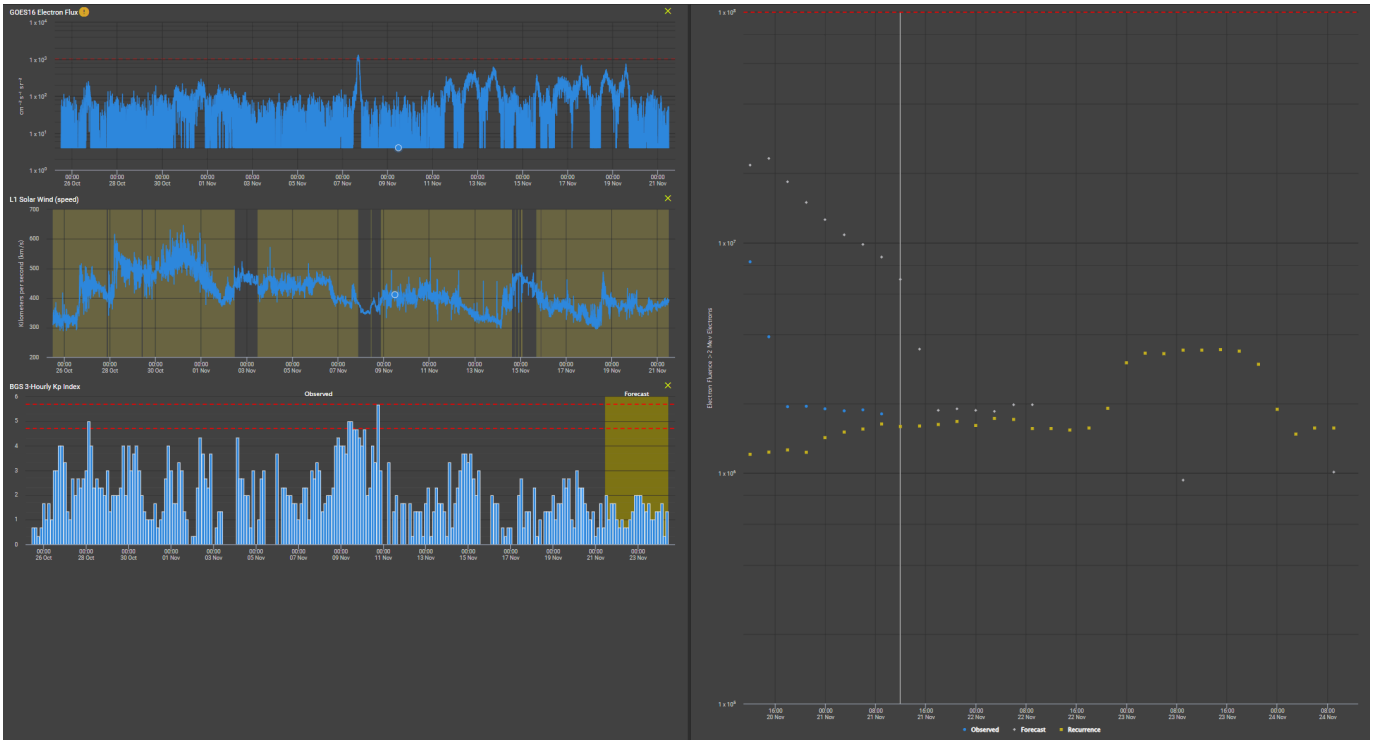
Figure 4: Measures of high energy electron-related activity in the past 27 days (left), from top to bottom: GOES16 flux; L1 solar wind speed (at ACE and DSCOVR) and BGS-measured 3-hourly Kp indices. No feature has proven capable of Active 24-hour integrated fluence and the latest MOSWOC REFM thoughts are therefore followed (right).



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